BEYOND SMART: OPTICAL NEURAL NETWORKS FOR INTELLIGENT EW

October 28, 2019

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Outline

GenXComm’s analog signal processing photonics platform

Optical neural networks for efficient and low latency artificial intelligence

Program overview

- Base phase objective
- Key performance indicators
- Phase timeline with milestones
- Overview of work program for each task
- Spend plan

Roadmap

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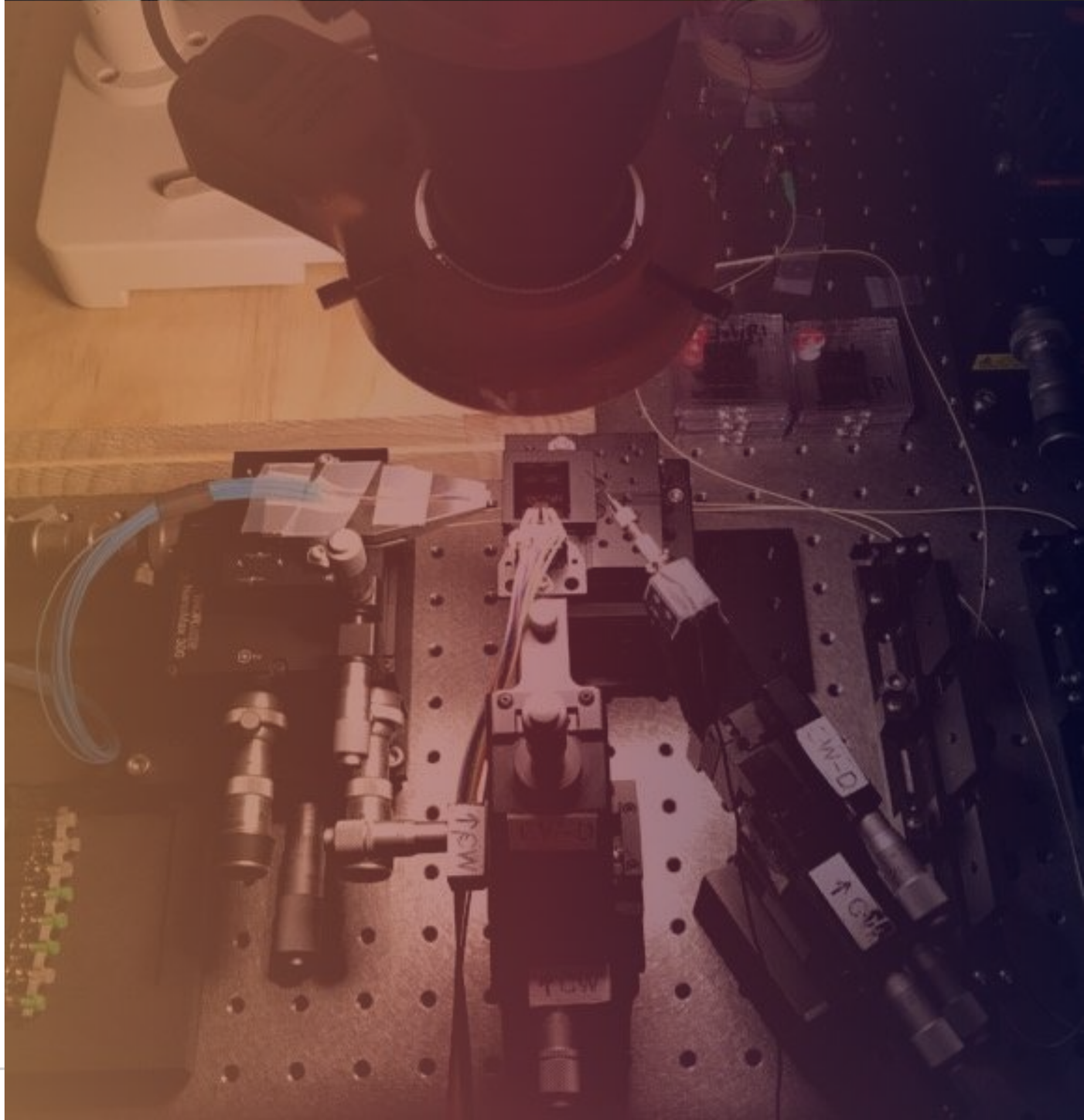
Delivering innovative RF-Photonic technologies for next generation communications, networking, computation and sensing.

Founded in 2016 in Austin, Texas
44 Employees

Series A in 2017

- Intel Capital
- Azure Capital
- FAM Capital
- Bandgap Ventures
- UT Ventures
- Capital Factory



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Our Team. The Right Mix of Passion and Experience.

Dr. Raghu Rao
SVP Advanced Technology

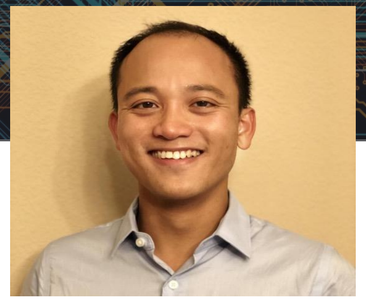
Dr. Hardik Jain
CTO and Co-Founder

Dr. Sriram Vishwanath
President/CEO and Co-Founder

Shari Joseph
CFO

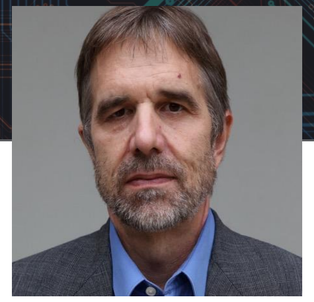
Gautam Talreja
Director of Engineering

Dr. Brian Mattis
Director of Process



Dr. Thien-An Nguyen
Director of Photonics

Dr. Dan Schwartz
Lead Systems Architect



Gary Raven
Head of Advanced Programs

GenXComm's Vertically Integrated Capabilities

Controls and Digital Processing

Build systems with simultaneous transmit and receive capability, improve spectrum efficiency by eliminating guard bands

Radio Frequency

Integration of photonics and RF capabilities to build systems for echo cancellation, interference suppression, phased array antenna setup

Integrated Photonics

Novel photonics components that allow wideband tunable delay lines, wideband tunable variable power splits, continuous variable amplification and attenuation

Chip Fabrication

GenXComm researchers and process engineers invent foundry processes that enable high performance photonic and RF devices.

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GenXComm Technology

Interference Cancellation

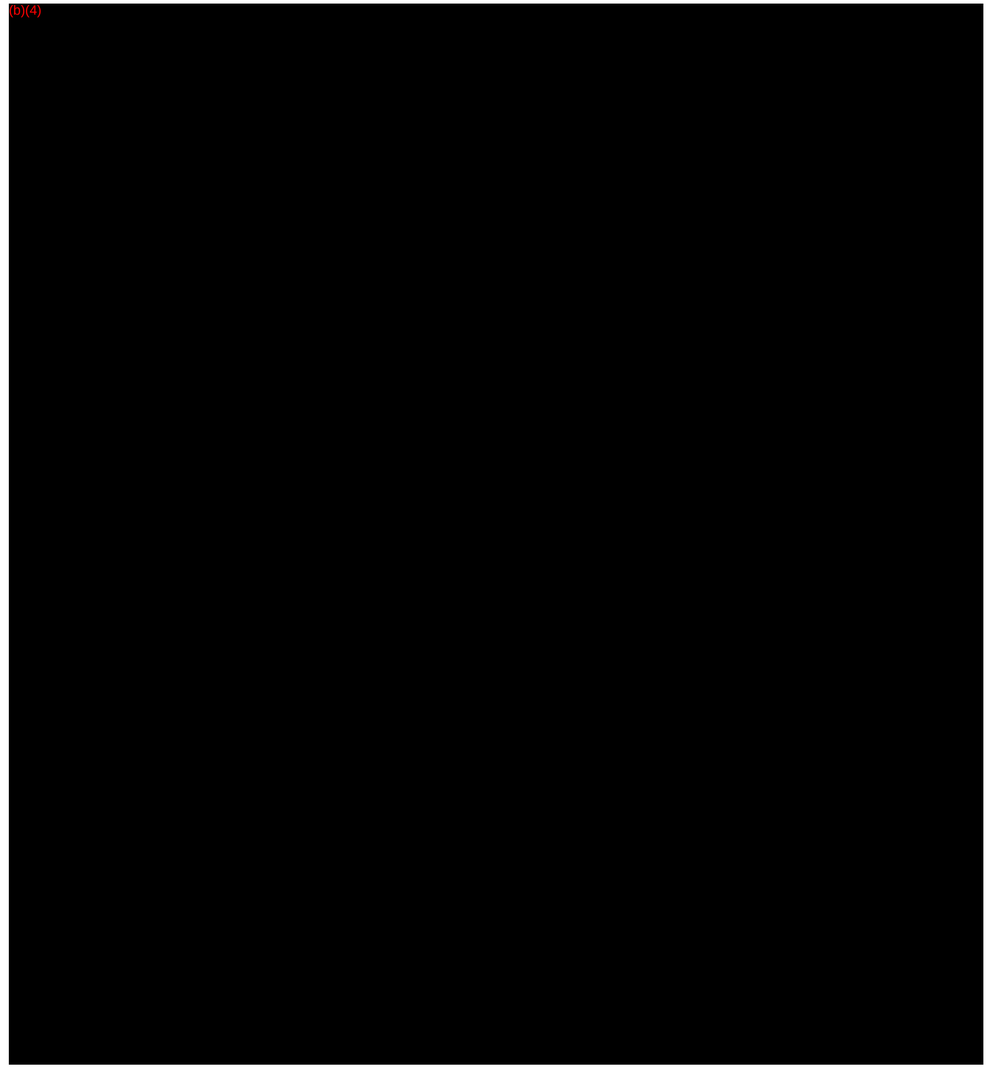
- Through RF, Analog and Digital cancellation system
- Cancellation for cable (DOCSIS, G.mgFast) and wireless systems (Cellular, WiFi, Bluetooth, Zigbee, proprietary radio)

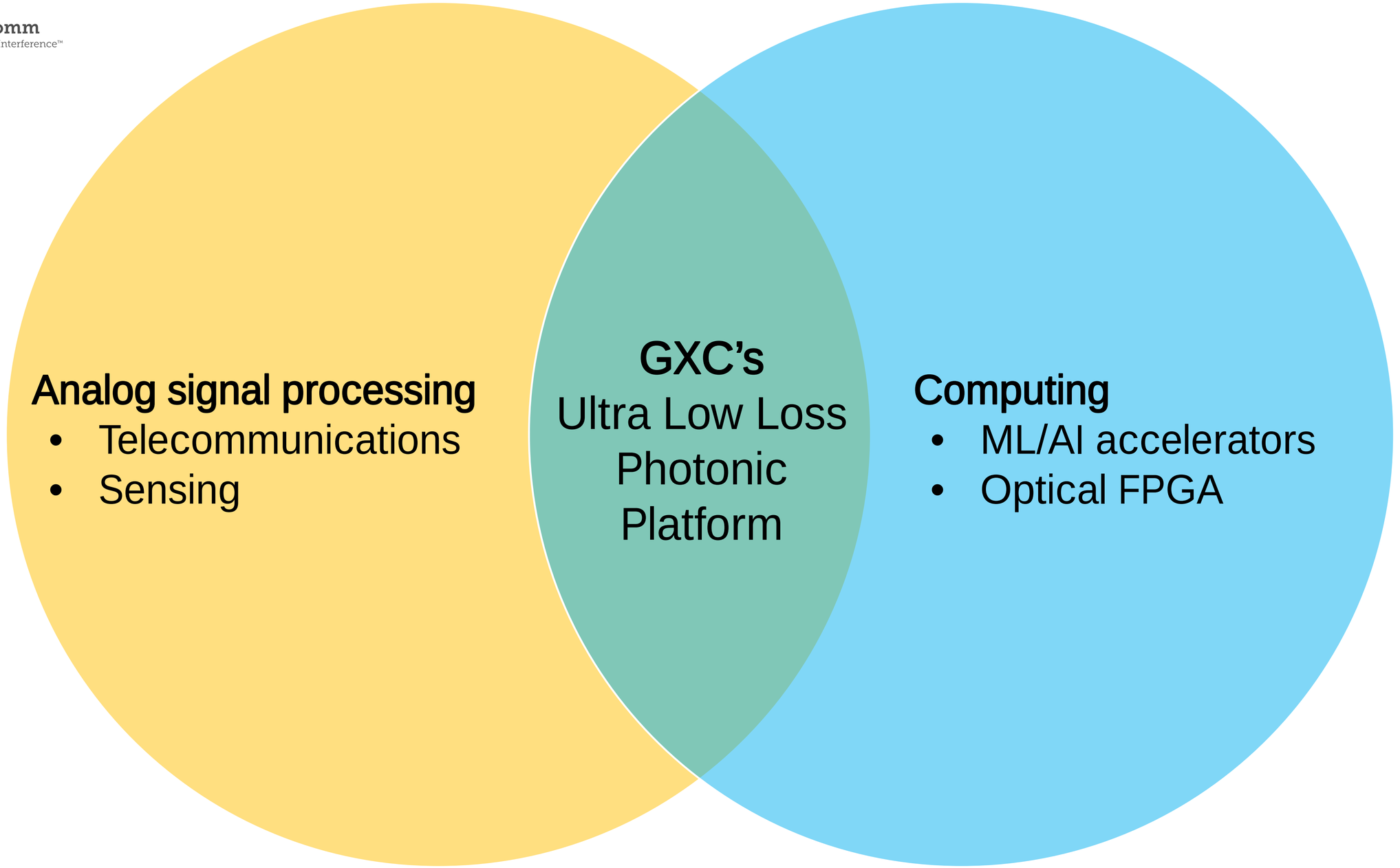
Unique RF Canceler

- Based on novel analog technology and integration
- Integrated solution for small formfactor devices

Linear and nonlinear signal processing

- Feedback loop between the cancellation system for fast convergence
- Cancel non linear distortions from RF frontend elements
- Passive intermodulation and reflections from environmental objects




Analog signal processing
• Telecommunications
• Sensing
GXC's
Ultra Low Loss
Photonic
Platform
Computing
• ML/AI accelerators
• Optical FPGA

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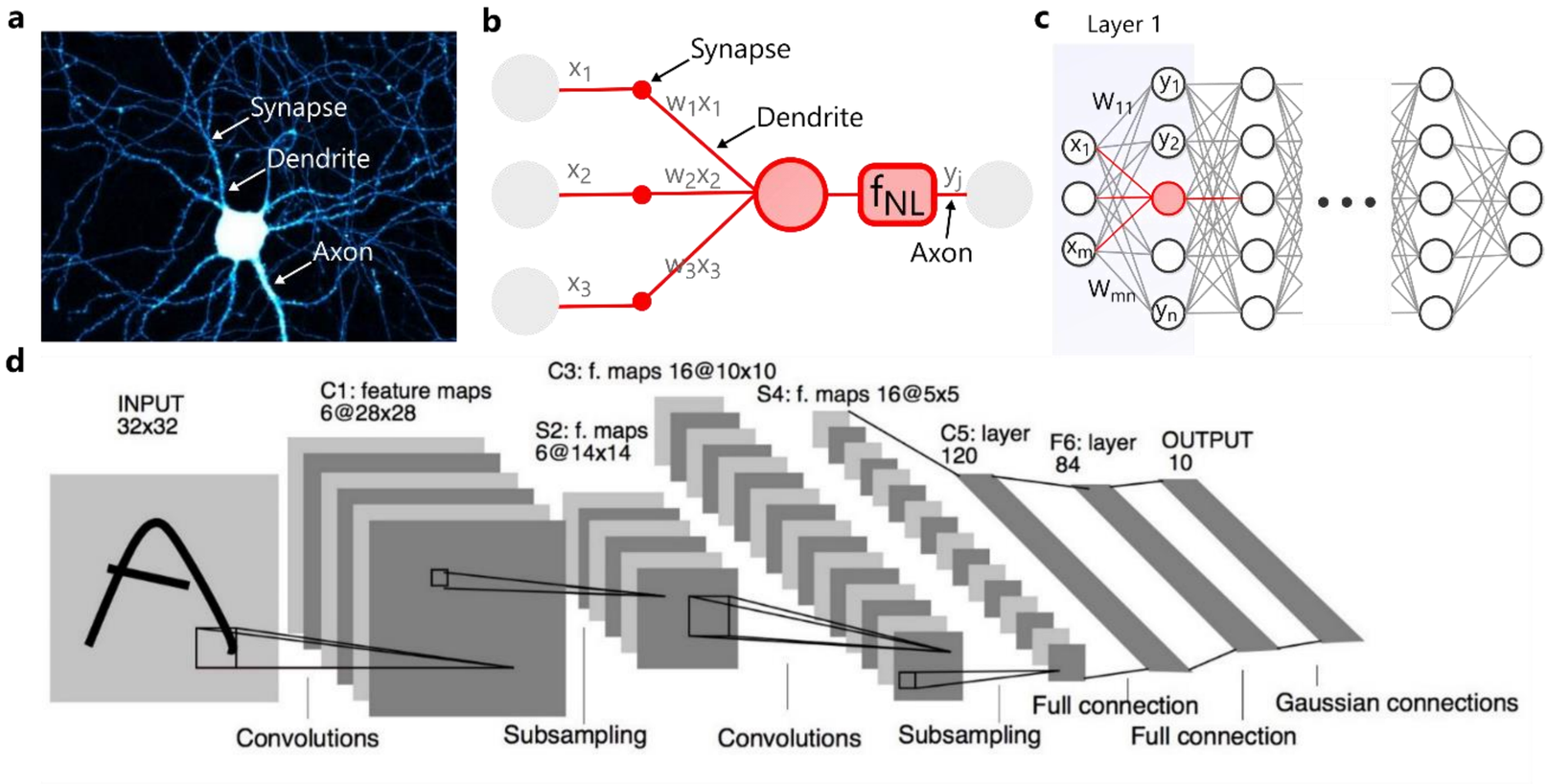
Deep learning emulates brain functionality with artificial neural network topography



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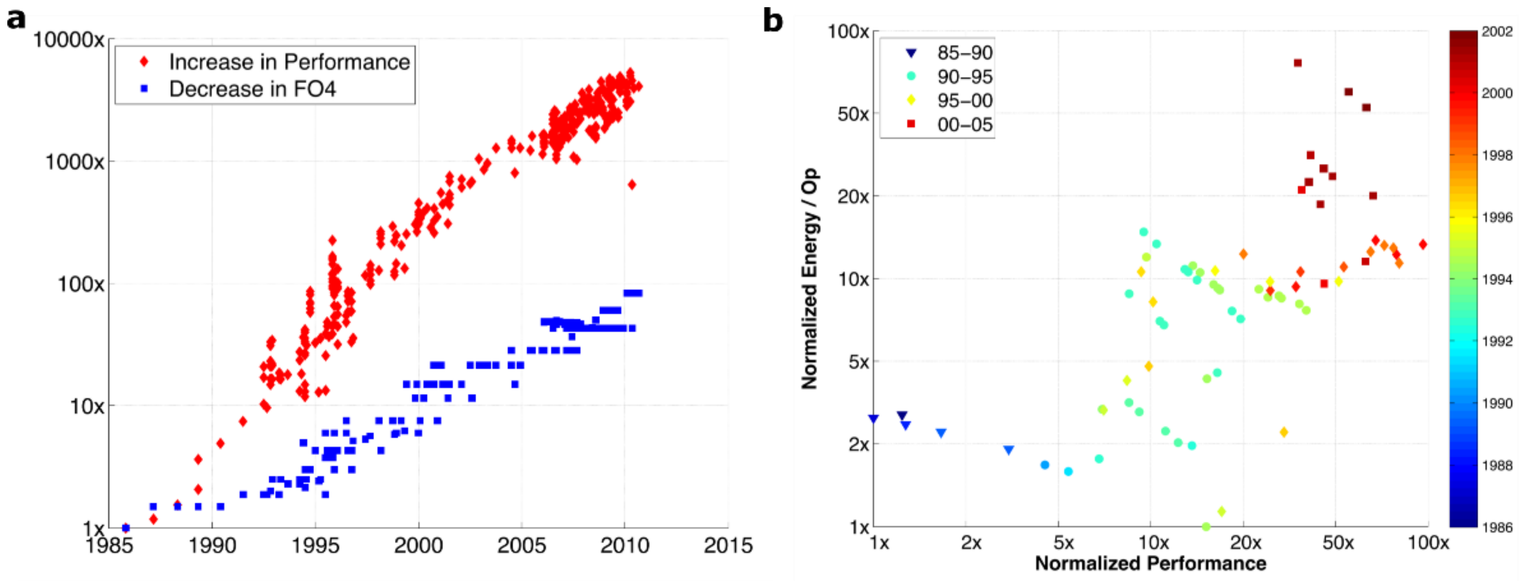
CMOS based neural networks are not energy efficient



Power limitations of CMOS technology have a twofold effect on scaling neural networks

- Imposes a tradeoff between throughput and latency.
- Prohibits deployment of artificial intelligence on edge computing devices for both inference and training.

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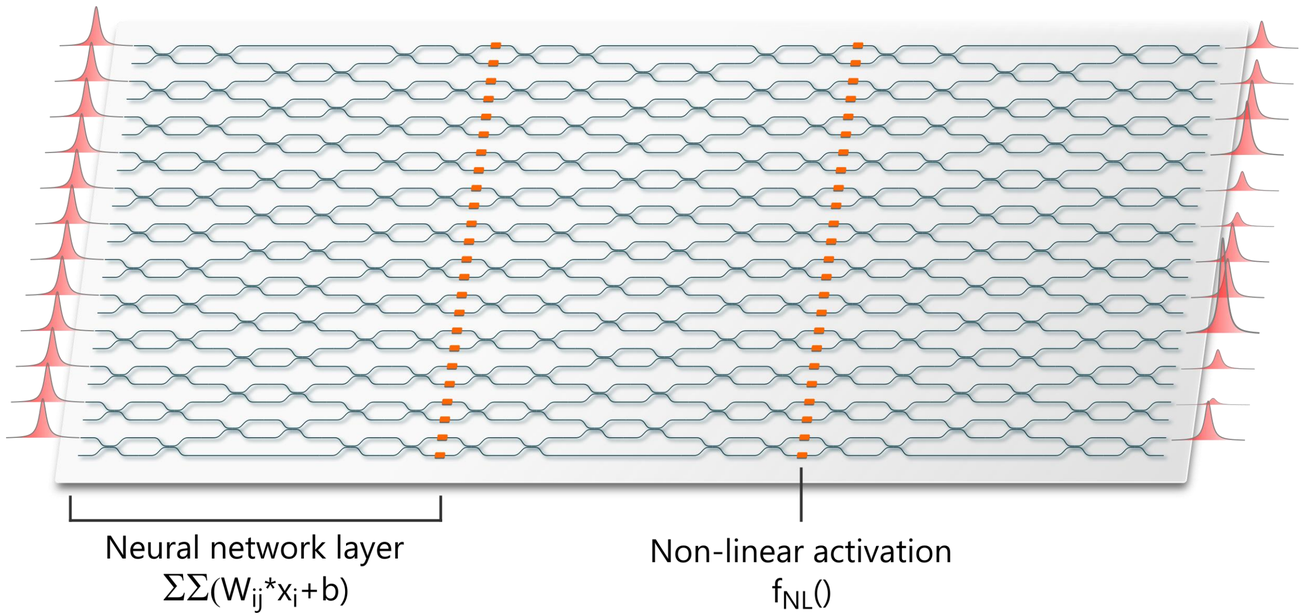
Real time and low power accelerators can be built on a photonic integrated circuit



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ONN for EW: (b)(4)

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Base phase objective

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Key Performance Indicators

Metric	Unit	Quantity
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Milestones

#	Milestone	Date	Description
M1	Program Kickoff	10/18/2019	Program Kickoff Meeting at ONR facilities to review program plan, schedule and objectives.
M2	Design Review	1/3/2020	Review of detailed module and system designs with ONR
M3	Delivery	3/13/2020	(b)(4) [redacted]
M4	Final Report	3/30/2020	Delivery of final report describing performance of ONN subsystem, roadmap for capability evolution and planned OY1 activities.

Deliverables

ID#	Deliverable	Date	Notes
A001	Progress Reports (Technical)	11/4/2019, 2/4/2020	Due quarterly
A002	Progress Reports (Financial)	11/4/2019, 12/4/2019….4/4/2020	Due monthly
A003	Program Review – Presentation Materials	11/11//2019	Due two weeks after the kickoff meeting.
A004	Final Report	3/30/2020	Due on last day of the contract
A005	Optical Neural Networks - Prototype	3/13/2020	(b)(4) 
A006	System Specification	1/3/2020	

Schedule

#	Major Task	Start	Finish	2019				2020		
				SEP	OCT	NOV	DEC	JAN	FEB	MAR
1	Kickoff and Performance Analysis	09/30/19	10/25/19		M1					
2	Modeling and Simulation	10/28/19	12/6/19				M2			
3	PAC and ONN Design	11/11/19	01/3/20							
4	PAC Development	1/06/20	3/13/20							M3
5	ONN Development	1/20/20	3/13/20							
6	Roadmap and Final Report	3/10/19	3/30/20							M4

Schedule Detail

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Spend Plan

Company/Organization: GenXComm, Inc.
Project Period of Performance (CY): September 2019 through September 2022
Month: September 2019

Government Fiscal Year	Funds Provided or Planned ($K)	Carryover From Prior Year ($K)	Funding Category	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Total Spent by 30 SEP
2019	393.5	N/A	Labor										0.0	0.0	0.0	0.0
			ODC										0.0	0.0	0.0	0.0
			Other										0.0	0.0	0.0	0.0
			Total										0.0	0.0	0.0	0.0
			Exp Plan													
2020	(b)(4)		Labor	(b)(4)												
			ODC													
			Other													
			Total													
			Exp Plan													
2021	(b)(4)		Labor	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			ODC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Exp Plan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2022	(b)(4)		Labor	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				0.0
			ODC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				0.0
			Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				0.0
			Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				0.0
			Exp Plan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				0.0

Tasks

Task 1: Kickoff and Performance Analysis

Deliverables: System Specification.

GenXComm shall perform a system level performance analysis to document key performance indicators (KPIs)

Tasks

Task 2: Modeling and Simulation

GenXComm shall perform system level modeling and simulation (b)(4)

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Tasks

Task 3: PAC and ONN Design

GenXComm shall perform design (b)(4) [redacted]

Simulation and design the following PDK components for use in an ONN

(b)(4) [redacted]

(b)(4) [redacted]

(b)(4) [redacted]

Tasks

Task 4: PAC Development

GenXComm shall fabricate and assemble the PAC. The PAC integrates data interfaces, PIC control circuitry, power supplies and optical components (see Technical Volume section 1.2.3).

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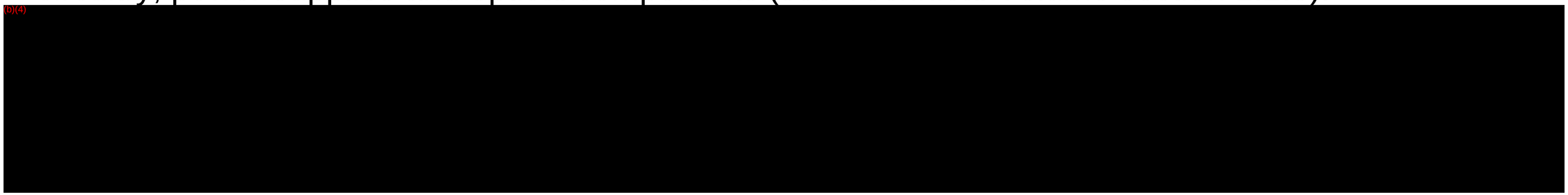

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Tasks

Task 5: ONN Development

GenXComm shall develop required software, firmware and logic (b)(4)

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Tasks

Task 6: Roadmap and Final Report

GenXComm shall provide Final report containing research summary, results and roadmap to scale ONN design in size and performance.

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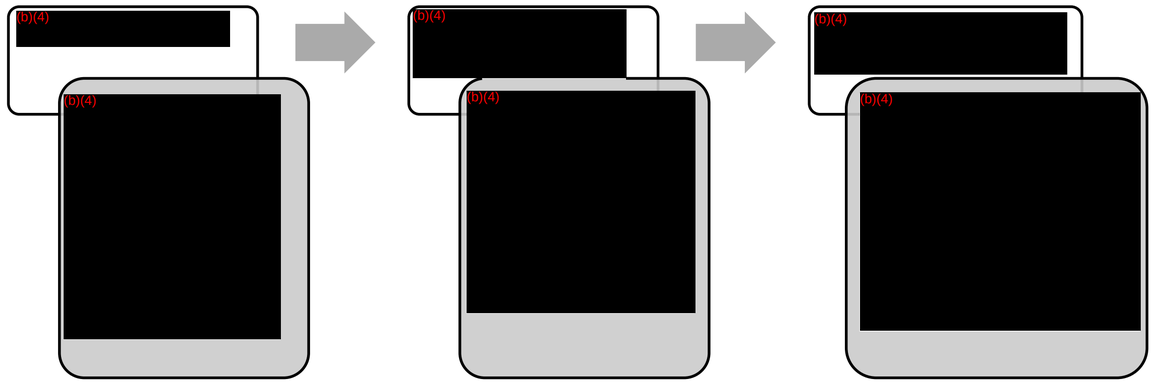
Successful completion of Base leads naturally into future capability improvements in Options 1 and 2



Metric	Unit	Base	Option 1	Option 2
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Thank you

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Computation using coherent light interference

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Reconfigurable optical matrix multiplier

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Williamson, I. A. D. et al. Reprogrammable Electro-Optic Nonlinear Activation Functions for Optical Neural Networks. ArXiv190304579 Phys. (2019).

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